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OF THE COSMIC RAY INTENSITY 40 m. w. e. UNDERGROUND

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BUDAPEST

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ABSTRACT

The existence of a 27 day persistent wave was checked in the intensity of the cosmic ray muonic component measured at a depth of 40 m w.e. underground at Budapest during the years 1958-1963. The maximum likelihood method with simultaneous meteorological corrections was used to analyse the data. No indication has been found for either a 27 or a 27.3 day wave.

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The 27 day variation of the intensity of cosmic radiation is usually thought of as being a recurrence tendency with changing amplitude and phase /see e.g. [1/a]/. In one case, however, a 27.3 day persistent wave has been found [2] with an amplitude of 0.07% by means of three ionization chambers sensitive to primary particles with energies of about 1.2 GeV, and 13 GeV respectively. The amplitude of 0.13% has been found [2] by means of an underground ionization chamber sensitive to primaries with energies of about 50 GeV.

The question arises, whether this persistent wave is still existing at higher primary energies. This has been investigated by means of the Budapest muon telescopes [3] placed at a depth of 40 m w.e. underground and having a total sensitive area of 4.41 m^2 . They are sensitive mainly to primaries with energies of about 10^{11} eV [1/b], [4]. The period March 1958 to November 1963 has been used. Data were grouped into three days intervals. Every 82nd day was omitted when investigating 27.3 day periodicity. The data measured during a three days interval were made use of during the process of numerical evaluation if

a/ at least one of the three telescopes was working satisfactorily during at least 50% of the three days interval and

b/ the corresponding meteorological radio sounding data were available. The correct functioning of the telescopes was checked by means of the differences of their counting rates. The improper work of even a single GM-counter could be detected this way..

The local barometric pressure and the height of the 200 mb isobaric level measured at Budapest Airport /18.5 km away from the underground laboratory/ were used to carry out meteorological corrections of the intensity data. The meteorological data themselves may have 27 day periodicities which may cause distortion of the primary 27 day variation or may give rise to a spurious 27 day wave. This can be avoided, if the meteorological coefficients and the constants characterizing the 27 day wave are determined simultaneously via the same equation of regression [5] . So as to proceed this way, the expected value of the cosmic ray intensity in the j-th three-day interval /j=1,2,...,9/ of the i-th 27 day period /i=1,2,...,p/ has to be written as

$$\langle n_{ij} \rangle = A + c_i + a_j + \beta_p(p_{ij} - p_{..}) + \beta_h(h_{ij} - h_{..}) ,$$

where A is the mean intensity,

c_i /i=1,2,...,p/ are constants characterizing slow changes of the intensity,

a_j /j=1,2,...,9/ are the constants characterizing the shape of the 27 day wave,

β_p is the partial barometer coefficient,

β_h is the decay coefficient,

p_{ij} is the measured value of the local barometric pressure,

$p_{..}$ is the arithmetic mean of the p_{ij} values /i=1,2,...,p;
j=1,2,...,9/,

h_{ij} is the measured value of the height of the 200 mb isobaric level,

$h_{..}$ is the arithmetic mean of the h_{ij} values /i=1,2,...,p;
j=1,2,...,9/.

The unknown parameters A, c_1, c_2, \dots, c_p , a_1, a_2, \dots, a_9 , β_p , β_h were determined simultaneously by means of the method of maximum likelihood [5] . An F-test was carried out to check whether the parameters a_1, a_2, \dots, a_9 differ significantly from zero. The results are given in Table 1., where

- q is the supposed period-length in days,
F is the result of the F-test,
p is the probability to get an F-value greater than the observed one merely because of random fluctuations, i.e. in the case when no periodicity exists.

Table 1

q	F	P
27	0.99	0.5
27.3	1.03	0.4

On the basis of Table 1. it can be seen, that at primary energies of about 10^{11} eV there is no indication for the existence of a persistent wave of the length of either 27 or 27.3 day.

DISCUSSION

Paper [2] does not indicate neither statistical errors nor significance levels, it is thus hardly possible to compare our results with those quoted in [2]. If the amplitudes quoted in [2] are significant, they still may be produced by meteorological effects, since no decay effect was taken into account in [2] neither was the barometer effect calculated simultaneously with the 27 day amplitudes.

Let us suppose, however, that there is a significant persistent 27 day variation in the intensity of primaries with energies 1-50 GeV. Such a persistent wave can most probably be produced by a persistent azimuthal asymmetry of the solar activity which would indicate an azimuthal asymmetry of the structure of the Sun. The lack of the persistent 27 day wave at energies ~ 100 GeV would indicate that particles of energies as high as that are not yet affected by the persistent azimuthal asymmetry of solar activity. It seems to be possible to draw some conclusions as to the order of magnitude of the persistent azimuthal asymmetry on the basis of the quoted observations. More detailed calculations and, last but not least, further measurements are needed to proceed in that way.

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